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# TOWARDS AN EVALUATION FRAMEWORK FOR MEDICAL WEB APPLICATIONS

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## Abstract

*The main aim of this study is to review and analyse various evaluation frameworks used to assess the operational effectiveness of various Information Technology (IT) processes/applications and identify their strengths in order to form a new holistic framework for economic evaluation of web applications.*

*This research aims to address the need for a new holistic evaluation framework for the purpose of the evaluation of the medical web applications. Over the last decade more and more, companies used accountancy techniques such as the frameworks analysed in this research. This new holistic framework that was developed will include also steps regarding the indirect and intangible costs and benefits identification and their incorporation in the evaluation process. Moreover the new emerging market of the medical websites and the embedded on them web applications requires also a new evaluation framework that will provide accurate results in the estimation of the efficiency of an investment on them.*

*The paper first presents an introduction about why economic evaluation is important when evaluating the Information Technology in organizations. Various studies are reviewed, which highlight the ever increasing importance of integrating economic evaluation processes, such as Cost Benefit Analysis (CBA) and Return on Investment (ROI), into systems and processes of organizations and economic organizations, and analyse the factors that govern their role.*

*Finally, the evaluation frameworks and methods that are found in these studies should be used as a part of a proactive systematic action plan that the organizations could use to avoid budget reduction due to incorrect planning. The next part of this study includes a comprehensive presentation and review of past frameworks used to evaluate Information Technology. The frameworks that are reviewed are the Framework for evaluation of information systems, the Information Technology Adoption Model (ITAM), the Total Evaluation and Acceptance Methodology (TEAM) framework, the ROI Process Model and HOT-fit evaluation framework for Health Information Systems.*

**Keywords:** Evaluation Framework, medical web applications

## 1. INTRODUCTION

The evaluation of IT interventions is an evolutionary and dynamic process that takes into account the ability of enterprise technologies to integrate information systems within and between organizations (Iran et al., 2008). After examining the established body of literature, various studies are reviewed, which highlight the ever increasing importance of integrating economic evaluation processes, such as Cost Benefit Analysis (CBA) and Return on Investment (ROI), into systems and processes of organizations and economic organizations, and analyse the factors that govern their role.

The main aim of this study is to review and analyse various evaluation frameworks that can be used to assess the operational effectiveness of various Information Technology (IT) systems/applications, with a view to form a new holistic framework for economic evaluation of IT processes/ systems and applications, by adopting their strengths while trying to minimise their weaknesses. Moreover this research aims to address the need for a new holistic evaluation framework for the purpose of the evaluation of the medical web applications. Over the last decade more and more, companies used accountancy techniques such as the frameworks analysed in this research. This new holistic framework that was developed will include also steps regarding the indirect and intangible costs and benefits identification and their incorporation in the evaluation process. Moreover the new emerging market of the medical websites and the embedded on them web applications requires also a new evaluation framework that will provide accurate results in the estimation of the efficiency of an investment on them.

Johanna Westbrook (2004) states that there are two main difficulties concerning the attempts to form a comprehensive evaluation framework in order to assess the impact of the IT systems/applications on the organizational processes and performance indexes of various organizations and organizations. The first one refers to the difficulty of how to identify and take into consideration all the aspects of IT and include them as features in one comprehensive framework. The second identified difficulty refers more to the evaluation process planning, focusing on the identification and collection of the data that will be needed in order to conduct the evaluation process and produce valid results.

Moreover, Puliam P. and Phillips J. (2008) point out that nowadays more and more organizations and organizations realise that evaluation processes such as CBA and Return on Investment are important and need to be integrated in their processes, Finally these evaluation methods should be used as a proactive and systematic action plan in order he organization to avoid budget reduction due to incorrect planning.

From their work arose the following conclusions:

- Evaluation is now a part of the design and plan of a process of the changes applied in most of the organizations
- Organizations are taking more proactive actions, using evaluation methods
- There is a systemization of the evaluation processes
- Technology helps evaluation processes
- Organizations realise that success can come only through careful evaluation planning
- Organizations that are not applying an evaluation process often suffer budget reductions or even budget eliminations.

Additionally, according to Philips (2007), the continuously growing budgets and program expenses force entities and organizations towards accountability and he identifies eleven universal trends concerning the impact of evaluation on the accountability. These eight trends are presented below:

- Evaluation is an internal process, part of the design development and functional life of a program.
- There is a tendency organizations to focus more on proactive actions and evaluation processes rather than post active.
- Evaluation methods have a methodology and a framework that guides the stuff involved in the evaluation process step by step during the whole process and this methods are also systematic
- Technology is enhancing evaluation processes
- Evaluation planning and comprehensive needs assessment, are considered now as the most important step and a crucial factor for the evaluation efficiency.
- Organizations that do not adopt evaluation procedures tend to have reduced their program budgets
- There are more and more successful examples of successful evaluation applications
- Evaluation methods do not consume vital resources and add only a small amount of extra costs to the program implementation

Delving into the work of William A. Estrem (2003) it can be stated states that evaluation of the web application is crucial since these applications are of great importance for the organizations as web services can be the tools to unchain organizations from their organizational boundaries and promote a better cooperation, communication and sharing of knowledge in a wider range of activities without place, time and other physical constraints (Estrem, 2003). In addition, he states that the evaluation should be developed in the context of a cost-benefit/effectiveness analysis although the determination of costs associated with web services is a very dull and complex estimation since it includes not only the initial costs from the acquisition, or internal development of a web service application but also it should incorporate the significant cost of the integration of this service in to the existing plan and system of the enterprise.

More specific, in the health care field, Johannesson M. (1996) stated that economic evaluations were based at their dawn on the human-capital approach according to which the value of the improvements in health care interventions is defined as “the decreased in consumption in health care and the increased production”. Soon after a strong criticism this approach was replaced by Cost-Benefit and Cost- Effectiveness and Cost-Utility analysis that are based more on the Willingness to Pay concept. Finally Chen M. (2009) suggests also that business management teams often are facing the problem of assessing the impact/ benefits of web services/applications. As he states that online web services are innovative technologies and so the costs related to them, that consist of technology infrastructure and development and training, are incremental but in general the cost of investing in web services is marginal. The benefits of the adoption/development of web services include the reusability of software reusability achieved by the development of common subroutines, “integration with legacy systems and leverage software assets, where web services can expose their functionality as service interfaces” and finally enhanced user experience and flexibility.

Moreover, in the recent years organizations like the National Institute for health and Clinical Excellence (NICE) in England and Wales and a growing number of health technology assessment (HTA) agencies were established around the world, resulting in the institutionalization of health care economic evaluation and aiming in the more efficient assessment of the technological and IT health care interventions (Brousselle and Chantale, 2011). As more and more decision making based on evidences rather than objective factors is needed then the economic evaluation will must be more effective to support managers and decision makers.

## **2. PAST FRAMEWORKS STUDIES REVIEW**

This section offers a comprehensive presentation and review of past frameworks used to evaluate IT processes and applications. The frameworks that are reviewed are: the Framework for evaluation of Information Systems (Gremmy et al, 1999), the Information Technology Adoption Model (ITAM) (Dixon, 1999), the Total Evaluation and Acceptance Methodology (TEAM) framework (Andrew Grannt et al., 2002), the ROI Process Model (Patricia Pulliam P. and Phillips J., 2007) and the HOT-fit evaluation framework for Health Information Systems (Mohd. Yusof et al., 2008).

These frameworks were chosen to be analysed since they are the most well established and well-known frameworks for the evaluation of the general and health related web applications/services. In order to form a new holistic framework for the evaluation of the medial web applications/services, it was considered important to gather information not only from frameworks applies in the health care IT field but also from generic ones, in order to have a clearer insight on the area under investigation.

In order to develop an economic evaluation process, researchers, analysts and decision makers should have a deep understanding of the relevant factors/ aspects of the evaluation process and take into consideration the perspective of the analysis and its main aims, boundaries and time limitations (Stone W. P, 2005). The boundaries of the evaluation process refer to the scope and the aims for which the evaluation process is undertaken. Moreover, it is proposed that sensitivity analysis and cost-effectiveness acceptability curves can be used to determine to what degree uncertainty can influence the results of the evaluation process and its results (Stone, 2005). According to Stone, the evaluation process should follow the steps presented in Figure 1 below:

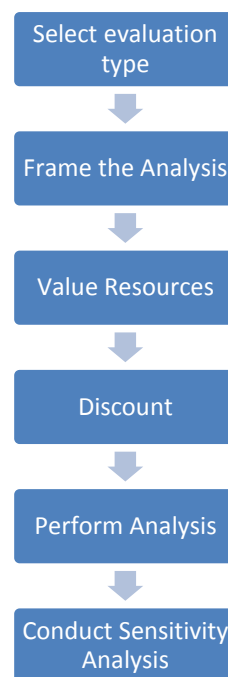


Figure 1: Economic Evaluation Process steps (Stone W. P, 2005)

Furthermore as Chen (2005) develops the components of this framework, he states that online web services are innovative technologies and so the costs related to them, that consist of technology infrastructure and development and training, are incremental but in general the cost of investing in web services is marginal. The benefits of the adoption/development of web services include the reusability of software reusability achieved by the development of common subroutines, “integration with legacy systems and leverage software assets, where web services can expose their functionality as service interfaces” and finally enhanced user experience and flexibility.

Gremmy et al (1999) presented a framework for evaluation of information systems (Figure 2). The framework includes 5 steps required to develop an information system (IS), starting from the general conception of the process that IS will enhance and ending with the assessment of the impact that IS has after its implementation within the process. In addition to this, the framework includes also the evaluation targets and the main shareholders/actors involved in every step of the IS development. Although this model is not an economic evaluation framework, it concentrates the most important step in an evaluation process and the key stakeholders that are involved in them, separating between the human and the IS factors.

Steps of the process	Step 1	Step 2	Step 3	Step 4	Step 5
Processes	General Conception	Preparation of the evaluation target	Execution of program	Output of the analysis	Impact accession
Evaluation targets	Model Creation Evaluation aims formation	Data collection		Interpretation	Assessment of social impact and decision making
Actors involved	Human	Human	IS & Human	Human	Human

Table 1: Gremmy's et al, (1999) IS evaluation framework

Furthermore, David Dixon (1999) presented the Information Technology Adoption Model (ITAM), which is the product of a combination of various theoretical models. This framework, in contrast to the afore – mentioned Gremmy's framework, focuses more on the human factor and more specific on the users of the new technological innovations implemented in the IT field, trying to predict the final decision that will lead to the adoption of the innovation, and its implementation or not. Except of the prediction feature, the ITAM can highlight areas where further evaluation should be implemented and new strategies can be applied. The most important aspect of this framework is that it incorporates the users' perspectives in the evaluation process and decision making, showing clearly that the development of IT innovations in general and in the case of this research of web applications/services should be user oriented and user-driven

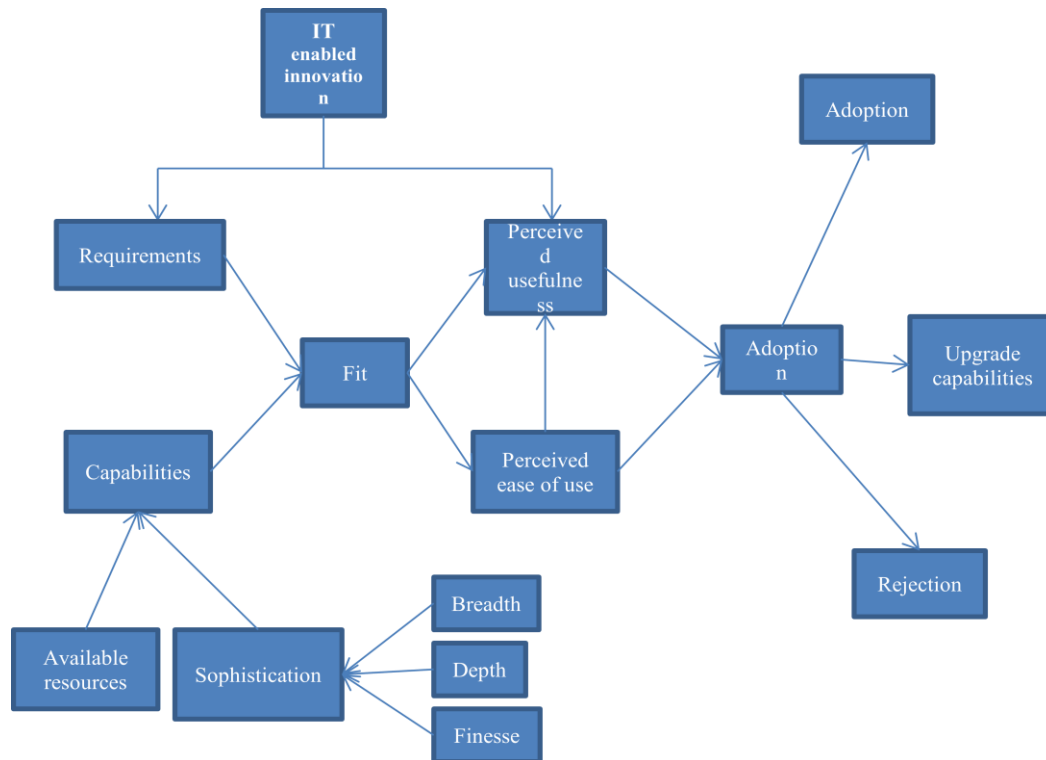


Figure 2: Information technology adoption model (ITAM) (Dixon, 1999)

Furthermore, Andrew Grannt et al. (2002) present the main areas where IT is used in health care and then introduce the Total Evaluation and Acceptance Methodology framework (TEAM) for the evaluation of health IS, particularly in biomedicine applications, although this methodology can have a broader application. The framework is conceptualised as a 3D model having on the x-axis the phases of the evaluation process, while on the y-axis lie the strategic, technical and operational evaluation targets. Finally, the z-axis includes the major actors of the evaluation process who are the stakeholders, the designers of the evaluation process, and the users. The framework represents very well the relationships between the actors and the steps involved in the evaluation process.

Chen M. (2005) suggests that business management teams often are facing the problem of assessing the impact/ benefits of web services/applications. Furthermore, based on his thorough study of past literature in the field he tries to develop a framework for analysing the forces that drive decision makers towards the acceptance or development and adoption of a web service/application. The framework is presented in Figure 2 and includes:

- Technological Factors
- The main actors/stakeholders
- The perceived benefits

The technological factors include the web service standards, the application architecture and the infrastructure and development tools. The main actors/stakeholder include the broad IT community, which is constituted from enterprise IT users and final consumers who put pressure on enterprises to produce integrated and innovative applications that will interact with the user, the IT vendors that must hear the IT users and adopt web services to enhance the user experience and to add more support elements, and various standard setting organizations that are setting the baseline and the foundation for the development of high quality web services/applications.



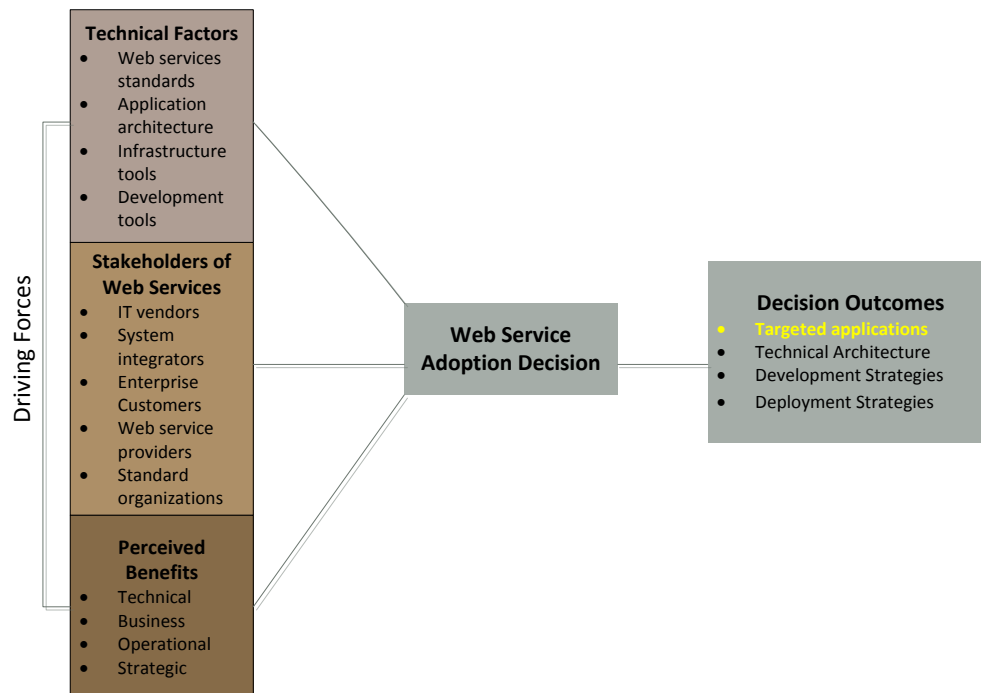


Figure 3: driving forces towards the adoption/acceptance

Furthermore, Jack and Patricia Pulliam Phillips (2007) created a comprehensive representation of the ROI methodology and its various levels/steps for the evaluation of complicated processes, where such processes are broken down into simpler steps. The levels of this ROI methodology are analysed below:

**Level 0 “Data Collection”** of the afore-mentioned representation of the evaluation methodology is the formulation of the objectives of the evaluation process. The main purpose of this level is to answer the questions below:

- What steps should be taken toward the implementation of the evaluation process and how many people are involved in the process?
- How much time has been spent on the implementation of the IS-enabled intervention and what is its cost to the organization?

**Level 1 “Reaction and plant action”** aims to examine if the intervention was successfully delivered and assess the importance and the relevance of the IS intervention to the work of the users as well as the intention of the users to apply what they have learned.

**Level 2 “Learning and confidence”** of the ROI methodology intends to measure what the potential users learned during the implementation of the IS intervention and how they are applying the new skills they developed.

**Level 3 “Application and implementation”** measures to what extend the users are applying what they have learned.

**Level 4 “Impact and consequences”** is focusing on the actual results achieved by the final users.

**Level 5 “Return on investment”** is the last and most important level of evaluation since it directly compares the benefits of the programme’s implementation against its costs - with ROI usually being expressed as a benefit-cost ratio.

Finally, the HOT-fit evaluation framework developed by Mohd. Yusof et al (2008), applied in the area of Health IS, is presented in Table 1. The HOT- fit Framework incorporates human technological and organizational characteristics in one comprehensive methodology. A similar framework, which could incorporate the same evaluation aspects and characteristics, can be used to

evaluate medical web applications. Thus with reference to Table 1, the aspects and evaluation targets that we consider to be more important with regard to the evaluation of the medical web services are highlighted. From the technological perspective, it is important to examine aspects concerning system quality, such as data accuracy and database depth of content as well as the security, the reliability and the efficiency of the system, aspects concerning the importance, accuracy, comprehensiveness/completeness and reliability of the information offered, and finally the responsiveness and support, as evidences of support quality of the service provided. With regard to the human dimension in the framework, it would be interesting to examine the purpose of use from the user's perspective, the users' expectations and their attitudes towards the information (acceptance), and their overall support. Also it is interesting to examine the nature of the organizations that provide the medical web services (non-profit organizations, non-governmental, health care system governmental organizations etc.) and their medical sponsors and support organizations.

HOT—fit						
Evaluation aspects	Technology		Human		Organization	
Targets	System Quality	Information Quality	Service Quality	System use	Structure	Environment
	Data accuracy	Importance	Responsiveness	Amount/ Duration	Nature	Financing sources
	Currency					
	Database Contents	Relevance	Support	Actual vs. Reported use.	Medical support and sponsorship	Competition
	Resource utilization	Usefulness	Effectiveness	Purpose of use, also the level of use		Population served
	Usefulness	Accuracy		Expectations		Users (Who is the user?)
	Reliability	Completeness		Attitude		
	Flexibility	Reliability		Acceptance		
	Security	Entry methods		Satisfaction of the user		
	Efficiency					
	Response time					

Table 2: The HOT-fit evaluation Framework

### 3. DEVELOPMENT OF A THEORETICAL FRAMEWORK FOR THE EVALUATION OF MEDICAL WEB SERVICES/ APPLICATIONS (MW S/A)

As it was mentioned above, the main contribution of this study is the development of a new theoretical framework formulated specifically for the evaluation of the medical web applications based on and using aspects from the above reviewed frameworks for the evaluation of IT and Information Systems (IS).

The framework (Figure 8) combines the strong elements from these existing evaluation frameworks, while trying to avoid or minimise their weaknesses. It includes five levels, similarly to the ROI Process Model (Patricia and Jack Phillips, 2000), and aspects from the HOT-fit framework (Mohd. Yusof et al, 2008).



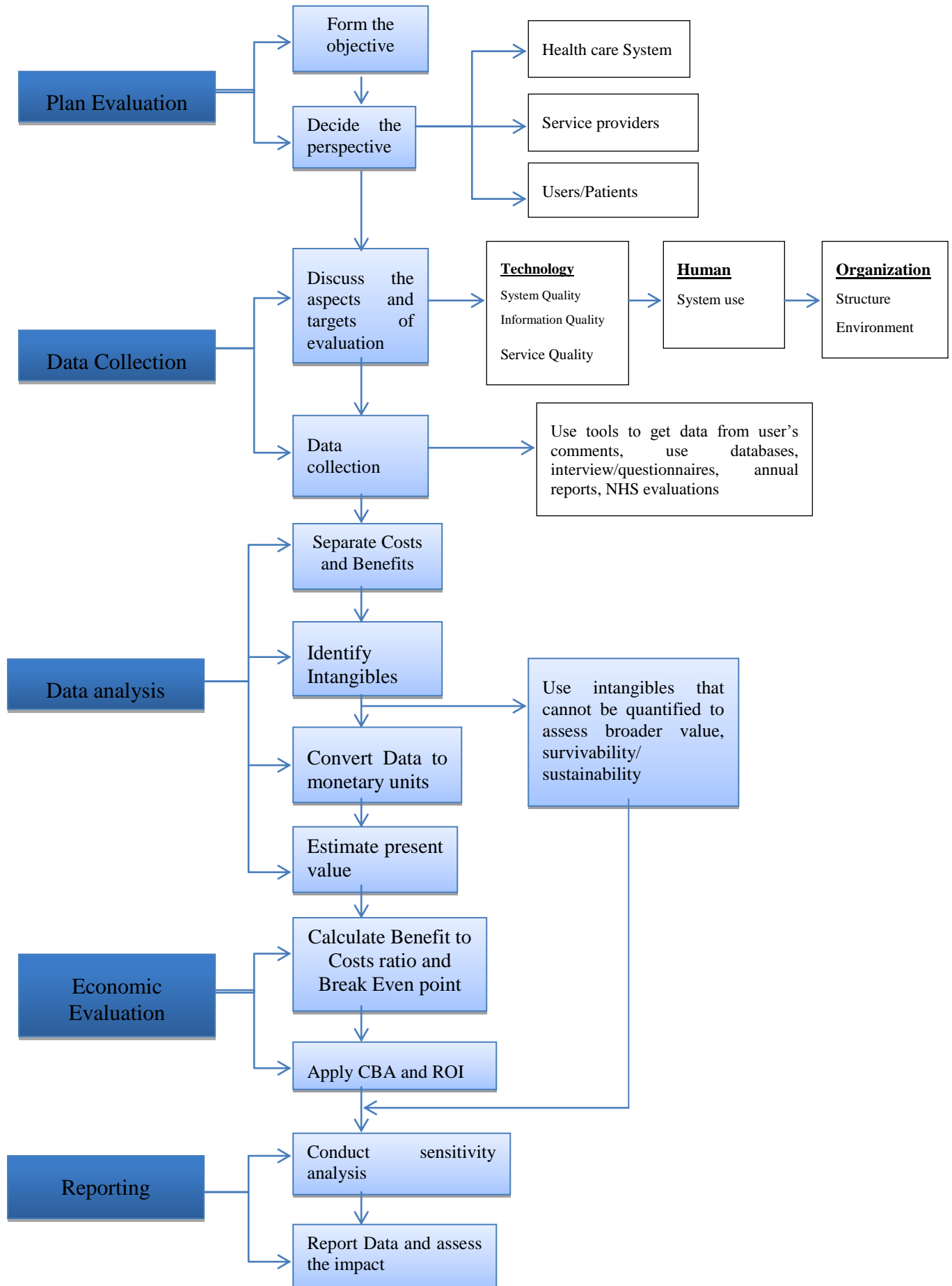


Figure 4 : Evaluation Framework for Medical Web Services

The first level of the evaluation is to plan the evaluation process by identifying and focussing its main objectives which in this case are the economic evaluation and efficiency assessment of an MW S/A. At this level, the scope of the evaluation must also be decided. The actors involved in the evaluation of medical web services have different points of view and expect different results from the evaluation process. This will help the analysts/ decision makers to form a comprehensive stakeholder analysis, by identifying the key stakeholders involved in the MW S/A, by analysing their interests and motivation, and the limitations that the developers of the MW S/A have to address and overcome in order to satisfy the key stakeholders. Moreover, "Influence vs. Interest" diagrams can help the decision makers to understand more clearly which actors are of high influence to and interest in the MW S/A, so that they can focus more on them. Furthermore, "Influence vs. Interest" diagrams among the key stakeholders are useful in order for the decision maker to identify the interrelationships among them.

The evaluation process described in the above paragraphs aims to enhance the efficiency of web medical services/ applications, and assess the return on investment and the net profits that these services/ applications can offer to their provider. In addition to this, the users of such applications demand enhanced reliability, accurate and comprehensive information, and ease of use.

The second level of the proposed evaluation framework refers to the focus that is needed on the main aspects of the evaluation target under examination and its specific characteristics. In order to evaluate medical web services, the technological, human and organizational aspects must all be taken into consideration in order to produce accurate and valid evaluation results with high level of confidence as well as generalizability (if and when needed).

The Technological aspects refer mainly to the system quality (data accuracy, database depth of content, reliability of the functionality of the service, security and response time), information quality (importance, relevance, usefulness, accuracy, completeness, reliability of information) and service quality (responsiveness, support, effectiveness). The Human factors refer to system usage by its users (purpose of use, expectations, attitude towards the information or service received, level of acceptance of the information) and user satisfaction (usefulness of the information received and overall satisfaction). Finally, the Organizational aspects that should be taken into consideration are the structure of the organization (nature of the organization, medical sponsorship and support) and the environment around the organization (population served, user base/community).

During the data collection process, databases, annual reports and reports from the National Audit Office can be used. Past studies, interviews and questionnaires can also be used as complementary, yet also very important, sources of data. Moreover, in addition to available data from interviews and questionnaires, IT tools that can analyse the users'/patients' comments on the respective medical web services' websites can provide vital data to assess the current state, future potential and survivability/sustainability of these services.

The next step following the data collection process is to establish/estimate the costs related to the development of the medical web services and also the corresponding benefits, which in the scope of this research, will be associated mainly to cost reductions and savings that arise from the use of these web services/ applications. The costs and benefits can be separated into three categories according to the three main actors, which, in the context of this research, are the Health care system as a whole, the providers of the medical web services, and the users/ patients. This simplifies the analysis, in terms of these three perspectives.

In addition to the above, intangible data should be also identified and attempts should be made to express them in monetary units. Various methods will be used in order to monetize intangible data depending on the specific characteristics of its intangible. For example, in case of web medical applications, if a value is needed to represent the value of the human life then the Sugden and Williams (1978) approach can be used. They propose that a more straightforward approach to value human life is to identify situations where individuals have a choice between 'safety' and 'extra monetary gain' and the value they attribute to 'safety', and in this way an analyst can derive the

minimum value of life, as equal to the monetary gain an individual is asking for, in order to fully compensate against living/working/interacting in a completely unsafe environment.

The intangibles that cannot be transformed into monetary units can be used to assess the broader value that the medical web services may have and also to assess the future potential and survivability of these services using qualitative methods.

The estimation of the present value and the discounting of the future value of the costs and the benefits involved in the development of IS interventions benefits are vital if the data are referring to past economic periods/years or a future projection of the evaluation results is required. Estimation of the future value is important for a complete and useful interpretation of the results. Robert Sugden and Alan Williams (1978) propose a solution to the problem of which rate is more appropriate to be used in the discounting process. One approach, they propose, is to seek for consistency between the criteria used to evaluate projects in the public and the private sector of the economy. Another approach is the time preference approach which refers to the existing difference of relative valuation placed on a good at an earlier period of time compared with its valuation at a later period of time and the discounting that is required in order to make the evaluation results at the two periods easily comparable to each other (Moseley W.G., 2001. Finally, they suggest that the best solution would be a synthesis of the two methods.

The next step in the evaluation process is the application of economic evaluation methods. Our suggestion is that Cost-Benefit Analysis (CBA) can be used in the context described by Robert Brent (2003), as a general method that will include also Cost-Efficiency Analysis, Cost-Minimisation and Cost-Utility Analysis as its special cases. Breakeven Point is the point where the costs associated with the development and implementation of the medical web services become equal to their benefits (Table 2).

<b>Benefits to Costs ratio</b>	Ratio of benefits to costs	$= \frac{\text{Benefits}}{\text{Costs}}$
<b>ROI/ CBA</b>	Ratio of adjusted benefits to costs	$\text{ROI} = \frac{\text{Benefits} - \text{Costs}}{\text{Costs}} [\times 100]$ $\text{CBA} = \frac{\text{Difference in Costs}}{\text{Difference in Benefits}}$
<b>Breakeven point</b>	Point where benefits meet or exceed costs	$= \frac{\text{Costs}}{(\text{Old Costs}/\text{New Costs}) - 1}$

Table 3

#### 4. CONCLUSION

In general, past frameworks used for the evaluation of IT and IS in various organizations like health care and education can have also beneficial results when adopted and applied (with appropriate adaptation and synthesis) in other related areas, such medical web services.

Although the framework developed in this study and formulated for the evaluation of medical web services is based on the same principles and components incorporated in successful past frameworks and highly promising with the potential to be very useful in the evaluation of such web services, particularly in assessing their efficiency and in enabling the providers of such services to understand better the users'/public's needs, the framework needs to be tested and validated in real-life context, and further research should be conducted in this direction. Finally, the important issues of generalizability and potential of the proposed methodology framework and approach in other areas, such as education, need to be further investigated.

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